

Low Dissolved Oxygen Monitoring Sites in Southeast Kansas

Since 2002 the Watershed Planning Section (WPS) has listed or developed TMDLs to address inadequate dissolved oxygen (DO) for 26 stream chemistry monitoring stations in the Neosho, Verdigris and Walnut River basins. At the present time 19 TMDLs have been developed and 7 stations are listed in the 2006 303(d) list for low DO impairments in the three basins. The WPS has adopted a methodology for addressing impairments that identifies low DO as an acute aquatic life stress, leading to listing as impaired if more than one sample fails to meet water quality criteria for every three years of sampling data available. Kansas has maintained a DO criteria of at least 5 mg/l for aquatic life support uses since the 1970s. For rotational monitoring stations, sites visited every four years, two or more low DO samples will result in an impairment designation and TMDL development under current methodology, and 4 or more low DO samples will result in an impairment designation for permanent sites, visited every year.

During the 1990's KDHE sampled these streams more often early in the morning than is current practice (Figure 1). Because of natural (diel) oscillation of DO levels over the course of the day, early morning hours are the times that DO tends to be the lowest. Thus it is not surprising that since 2000 there have been relatively fewer low DO samples recorded (Figure 2), since most are sampled in the afternoon.

However, not capturing a low DO sample does not mean that the stream has recovered full support of its aquatic life support use. In 2007 the WPS initiated an effort to investigate the causes of stream impairment.

To better understand the source of the impairment we first examined the existing stream chemistry data to determine if any significant correlations existed between times of low DO and other measured parameters. This analysis showed that season and time of day were both important factors, with most low DO events occurring in the summer and fall. It also revealed strong correlations with aluminum, manganese, pH and sulfate concentrations. Overall concentrations of these constituents were low or comparable to other sites statewide, suggesting that they were not the cause of the impairment. Instead it appeared that the variation in these constituents was simply a good indicator that a likely impairment occurred.

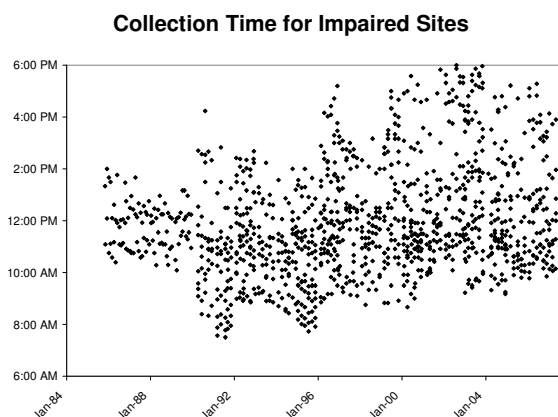


Figure 1

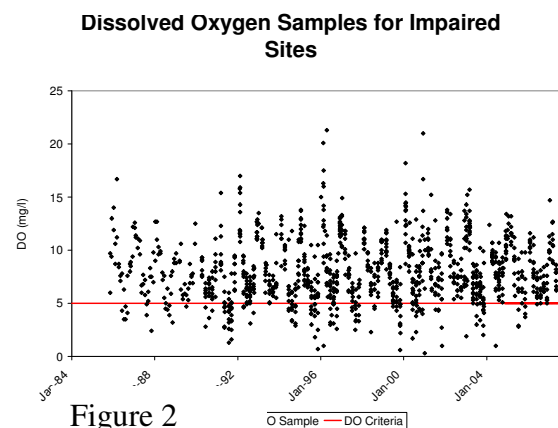


Figure 2



Figure 3

large gravel bars (Figure 3) impeding the flow of the streams at low flows, typical of late summer and fall periods. When combined with bedrock control, which significantly limits the ability of water to travel beneath and around a gravel bar, these flow impediments can restrict in-stream flow. Travel through gravels bars would be expected to result in the conditions noted above, e.g. elevated manganese, adjusted for sulfate & aluminum.

A field study was conducted to determine if a naturally occurring condition might explain the underlying cause of the DO impairment, and focused on the possibility that low flow and regular interaction with gravel bars might be a major contributing factor to the low DO events. Using standard KDHE protocols, a bridge and bucket sampling effort was conducted on Homer Creek (SC574), West Creek (SC290), Walnut Creek (SC576), and the Fall River (SC575) in the Verdigris basin and Big Creek (SC611) and Canville Creek (SC612) in the Neosho Basin. Field investigation confirmed the presence of

Further analysis was completed on the stream chemistry data using a principal components method to determine which other sites could be expected to be similar to the five visited sites. Results indicated that three groups existed. Group 1 sites were sufficiently different from all others, that they could not be judged to be similar to the remaining sites. These sites were excluded by high sulfate levels (SC676 – French Creek) from known gypsum deposits, perhaps indicating a differing regional geology, low pH and high sulfate (SC605 – Cherry Creek) from mined land waste, and point source discharges (SC211 – Turkey Creek and SC567 – Cow Creek). Of the remaining sites, two groups were indicated, differing primarily in nutrient profiles and geologically derived constituents. Group 2 sites may be under the influence of some naturally occurring restrictions on flow, but also have generally higher nutrient concentrations that cannot be ruled out as a possible contributor at this time. Group 3 sites have profiles that match the visited sites, and are likely under the primary impact of naturally occurring conditions.

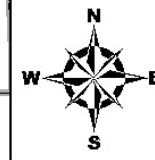
Watershed Planning Section is now moving forward to provide guidance to the triennial review of Kansas water quality criteria to better reflect naturally occurring variation in DO concentrations. In the meantime, we recommend that sites in Group 1 remain listed as highest priority impairments, until further studies can determine the level of human impact, Group 2 sites be place in a medium priority status, reflecting their possible human impact combined with naturally occurring conditions, and Group 3 sites be placed in the lowest priority status until new water quality criteria can be established, which will likely lead to their ultimate delisting as impaired waters.

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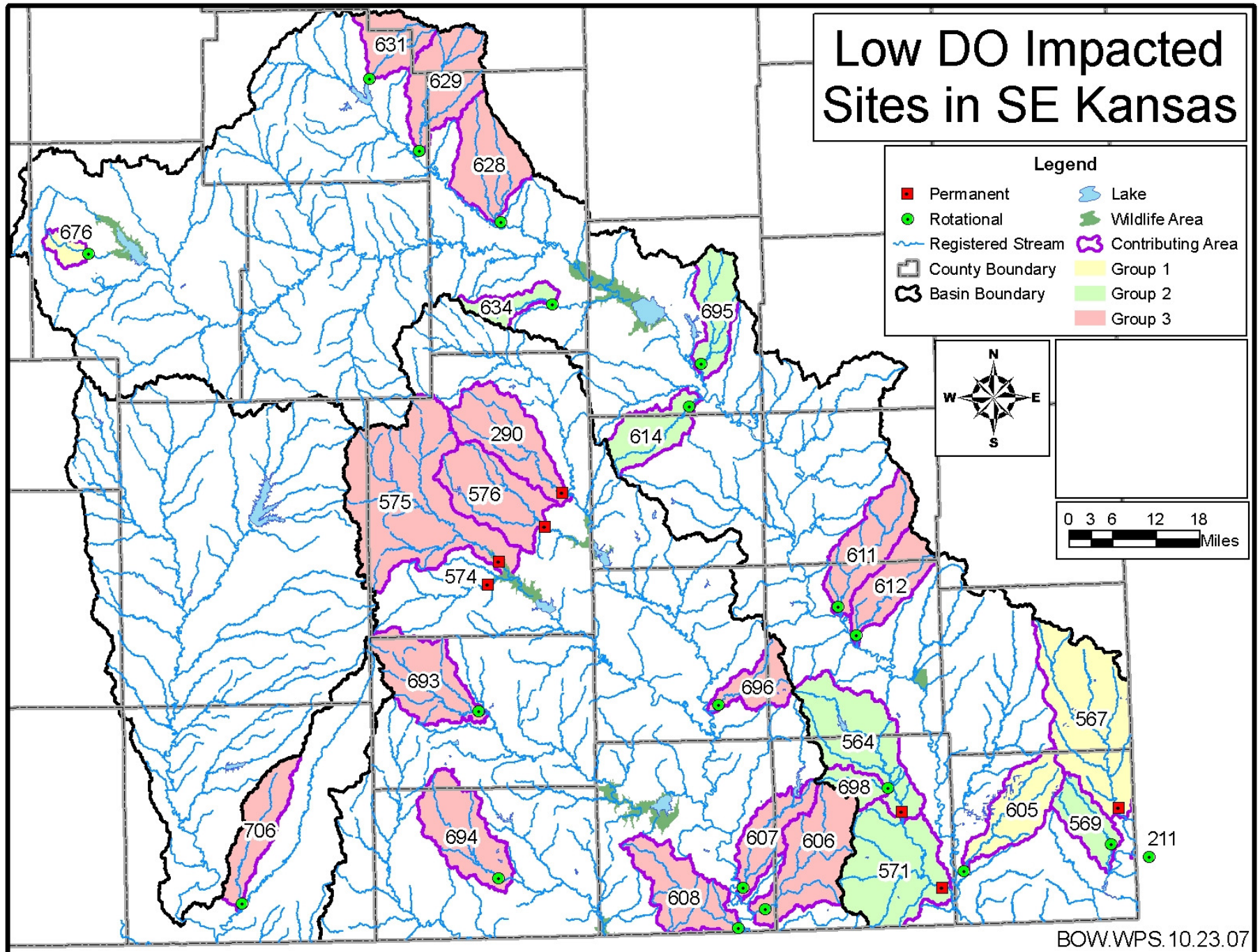
Low DO Impacted Sites in SE Kansas

Legend

- | | |
|---------------------|---------------------|
| ■ Permanent | 🌊 Lake |
| ● Rotational | 🌿 Wildlife Area |
| 🌊 Registered Stream | 🔗 Contributing Area |
| 🗺 County Boundary | 🟡 Group 1 |
| 🔗 Basin Boundary | 🟢 Group 2 |
| | 🟠 Group 3 |



0 3 6 12 18
Miles



BOW.WPS.10.23.07

Site Code	Alkalinity	Aluminum	Calcium	Iron	Manganese	Nitrate	pH	Potassium	Specific Conductance	Sulfate	TDS	Total Hardness	TP	Turbidity	TOC	Kjeldahl Nitrogen	TN	DO Samples *	Low DO Samples Prior to 2003*	Low DO Samples Since 2003*	Low DO Temp.
SC211	147	0.08	80	0.12	0.05	3.28	7.70	6.98	555	81	338	224	1.22	3.30	5.47	1.45	6.40	77	11	0	22
SC567	85	0.38	74	0.67	0.72	0.80	7.40	6.86	876	273	574	305	0.27	10.00	6.33	0.57	1.50	100	6	2	22
SC605	72	0.57	138	0.97	1.07	0.12	7.30	6.03	1230	537	866	548	0.08	11.80	6.95	0.62	0.77	21	6	3	22
SC676	400	0.84	242	0.88	0.54	0.24	7.70	5.48	1642	563	1190	980	0.14	15.00	7.58	0.65	1.02	24	2	0	20
Avg.	176	0.47	133	0.66	0.60	1.11	7.53	6.34	1076	364	742	514	0.43	10.03	6.58	0.82	2.42	55.50	6.25	1.25	21.50
SC564	114	0.75	43	0.90	0.18	1.03	7.50	5.62	377	45	226	135	0.34	17.00	8.14	1.13	2.15	99	8	3	23
SC569	34	0.97	20	1.43	0.24	0.42	6.95	5.54	218	43	137	74	0.11	19.80	8.76	0.94	1.17	22	6	0	22
SC571	109	0.78	43	0.98	0.17	0.28	7.60	4.83	341	34	197	131	0.15	23.00	8.19	0.91	1.38	99	7	2	22
SC614	115	0.79	42	1.25	0.15	0.10	7.55	3.33	327	19	195	133	0.11	24.80	7.90	0.57	0.72	21	3	0	12
SC634	212	1.22	66	1.76	0.17	0.39	7.50	4.06	520	61	312	224	0.14	19.90	11.63	1.55	2.53	15	2	0	25
SC695	174	0.53	58	1.25	0.41	0.10	7.40	4.43	418	22	257	186	0.16	16.00	9.98	1.24	1.59	17	4	3	15
SC698	129	0.44	51	0.94	0.48	0.15	7.40	4.35	387	38	245	167	0.13	14.20	10.81	0.97	1.12	17	7	2	25
Avg.	127	0.78	46	1.22	0.26	0.35	7.41	4.59	370	37	224	150	0.16	19.24	9.34	1.04	1.52	41.43	5.29	1.43	20.57
SC290	215	0.42	76	0.59	0.13	0.10	7.90	2.89	624	31	354	246	0.05	10.80	5.60	0.44	0.64	150	15	1	24
SC575	225	0.52	73	0.53	0.08	0.20	8.00	2.57	546	22	310	242	0.06	10.00	3.58	0.36	0.68	99	3	0	22
SC576	201	0.37	69	0.45	0.13	0.10	7.80	3.18	479	25	269	219	0.05	10.40	5.13	0.50	0.62	98	9	0	23
SC606	154	0.49	61	0.48	0.16	0.10	7.70	4.28	436	25	238	181	0.09	9.00	6.64	0.46	0.61	23	5	1	21
SC607	156	0.51	70	0.95	0.26	0.11	7.60	4.02	665	86	359	226	0.08	11.50	6.51	0.79	0.98	23	4	0	20
SC608	151	0.51	56	1.02	0.24	0.17	7.60	3.98	505	31	282	177	0.06	9.90	5.74	0.52	0.84	22	6	1	20
SC611	174	0.33	67	0.53	0.11	0.13	7.70	2.90	402	21	234	191	0.10	11.10	5.08	0.58	1.03	24	2	0	13
SC612	170	0.32	68	0.49	0.14	0.15	7.60	2.81	406	26	240	192	0.09	8.00	4.29	0.46	0.66	23	4	0	15
SC628	210	0.57	72	0.75	0.23	0.19	7.70	4.28	528	41	320	234	0.15	11.00	8.84	0.98	1.24	29	2	2	12
SC629	227	0.62	77	0.58	0.15	0.18	7.90	2.86	506	35	298	245	0.14	10.40	3.55	0.52	0.67	26	1	1	27
SC631	199	0.82	66	0.82	0.21	0.16	8.00	4.06	445	26	275	209	0.12	16.20	6.20	0.73	1.23	21	2	0	24
SC693	202	0.26	59	0.41	0.09	0.24	7.90	2.61	458	18	246	203	0.05	7.54	4.16	0.38	0.67	22	2	0	18
SC694	176	0.23	60	0.41	0.10	0.10	7.70	2.93	454	10	238	178	0.04	7.50	4.25	0.24	0.39	26	2	0	18
SC696	168	0.26	64	0.55	0.20	0.10	7.55	4.45	547	61	322	220	0.10	10.30	5.36	0.61	0.78	16	3	0	21
SC706	222	0.46	76	0.39	0.08	0.26	7.90	1.84	504	13	284	217	0.07	9.89	2.42	0.37	0.98	19	2	0	20
Avg.	190	0.45	68	0.60	0.15	0.15	7.77	3.31	500	31	285	212	0.08	10.24	5.16	0.53	0.80	41.40	4.13	0.40	19.67

Median concentrations of selected constituents at impaired sites; *-This column is a count of samples, not a median